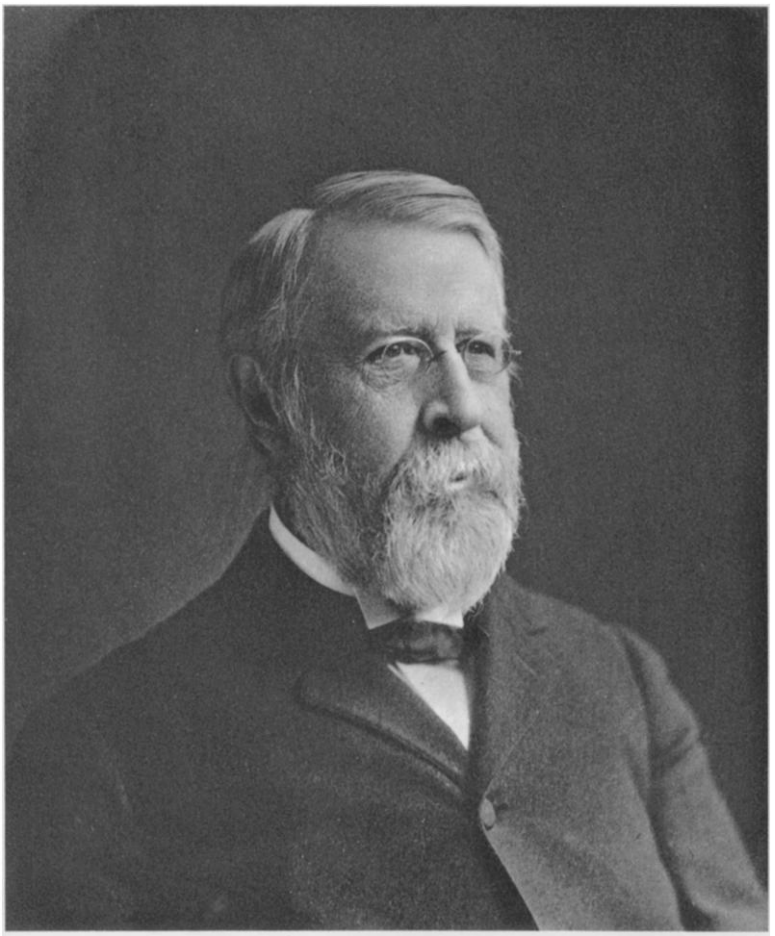
GEORGE FREDERICK BARKER, M.D., Sc.D., LL.D.

(Read May 5, 1911.)

When the present writer was asked to prepare a memorial notice of Dr. George F. Barker, he felt some hesitancy, believing that some other and closer friend would be better fitted to undertake it. Still, there had grown to be a strong bond of friendship and sympathy between Dr. Barker and himself, increasing with the flight of years. Both began life as chemists, and both spent their earlier years in teaching that science, while maintaining all along an unbroken interest in its advance. Both were early trained in the mechanical workshop as constructors. Together, through many years, they witnessed, and themselves assisted in, that great extension of electrical science and its applications to the arts and industries, which have so greatly changed the conduct and convenience of modern life. Contemporaries they were, from its very inception. They were fellow delegates to international congresses of electricians, fellow members of several scientific and technical national societies, including the American Philosophical Society.

The writer may be pardoned for adding that in scientific tastes, there was many a bond of sympathy between them. The great advances in astro-physics, the researches in chemical physics, the wonderful discoveries in Roentgen rays, and the later epoch-making investigations in radio-activity, aroused in them a like interest. Above all, the friendship that had existed for so many years was of a kind which time could but ripen and increase. Dr. Barker was constant in his attendance on important scientific gatherings, and active in their work, and when a year or so before his death he was compelled to remain away owing to illness, his absence was at once noticed and regretted. His cordial greeting so warmly given and earnestly reciprocated was missed by his friends, who did not then know that the end of a most useful life had almost come, and that



George F. Barker.

they were to see him no more. The writer, since the early seventies when Dr. Barker came to Philadelphia, had enjoyed his friendship and kindly appreciation, and his loss has left a gap never to be closed.

Nevertheless, he survived many of his associates, if only for a short time. In 1891 he headed a committee of five members of the National Academy of Sciences, appointed to report on the Henry Draper Medal, the others besides Dr. Barker being Wolcott Gibbs, Simon Newcomb, and C. A. Young, and Professor A. W. Wright, who is the only one who now survives. It was when Dr. Barker took the chair of physics in the University of Pennsylvania that the writer first had the privilege of his acquaintance. He was then among the faithful attendants upon the meetings of the American Philosophical Society, of which he became a member in 1873 and later, as is well known, served as an officer of the Society, acting as Secretary from 1877 to 1897, and also as Vice-President, between 1899 and 1908.

The record of the scientific work of Dr. Barker is distinguished by remarkable versatility. Moreover, his temper of mind was such that, while giving full worth to research in so-called pure science, he did not lose sight of the practical application of scientific principles as a most important factor in human progress. As a chemist he dealt ably with the purely theoretical side of chemical problems, yet was an eminent and trusted practical chemist. He gave a large fraction of his life's work to abstract physical science, but was ever keenly interested in engineering. Nor did he fail in extending this interest to other branches of science besides those which he had made peculiarly his own. We find him observing transits and solar eclipses, and making and recording observations in astronomy with the same ability and enthusiasm which he manifested in chemistry or physics. Even in his later years we find the same acute interest in his studies and work in Roentgen rays and radio-activity. It was also true that at all times he showed for the work of others a generous appreciation and interest, and when such work commended itself to him he was not slow in assisting towards its proper recognition.

As a friend and associate he was held in the highest personal

regard by those who knew him, and his death brought to them a deep sense of irreparable personal loss. His earnest interest in science is attested by the numerous papers which form a partial record of his thought and work, while his fine personal traits remain to those who new him as a memory which will not soon fade.

In the early Philadelphia days Dr. Barker lectured frequently in public to large and appreciative audiences. He spared no pains to interest and instruct those who attended. Was there a new development or discovery in science, he strove to make his auditors appreciate it as he did. His mechanical and practical skill was of great aid in devising and arranging apt and often brilliant experimental illustrations, with which his popular lectures were crowded. It was the writer's privilege as a young man to be present on a number of such occasions at the Academy of Music, and he remembers vividly a lecture on electric lighting in which, as a unique feature, an early Gramme dynamo, secured from abroad by Dr. Barker, was driven by a gas engine, and used to furnish the electrical current. Before that time a large voltaic battery, almost prohibitive from its cumbersomeness and cost, would have been required to produce any semblance of the brilliant effects of the electric arc then shown. This was at a time when there was but little appreciation of the possible great future growth of electric lighting, and about two years before the invention of the incandescent lamp by Edison.

As a natural result, however, we find that Dr. Barker was not only, from the first, in personal touch with Edison in his pioneer work, but was one of those deeply interested in his early incandescent lamp development. More broadly it can be said that throughout his long service to science, Dr. Barker followed with special ardor the rapid and important growth of electrical science which has continued in the intervening years.

When the American Philosophical Society celebrated the 150th anniversary of its foundation, it was he who, under the title of "Electrical Progress Since 1743," studiously reviewed the advance of electrical science due to workers such as Franklin, Faraday, Hare, Henry and others. As another evidence not only of his deep

interest in electrical advancement but of the early recognition of his foremost position at the time, he was appointed U. S. Commissioner to the Paris Electrical Exposition held in 1881, and an official delegate to the Electrical Congress then held. This was indeed a famous congress, by which much work of vital interest and importance was either accomplished or initiated, particularly concerning the nomenclature of the several electrical units, and the evaluation of standards; a work which has been continued by the subsequent international chambers of delegates at each of the important Congresses held since that time; the last being that at St. Louis in 1904.

At the Paris Exposition of 1881, which was the first exposition to be devoted to electricity solely, Dr. Barker was also made vice-president of the Jury of Awards, and in recognition of his services received the decoration of Commander de la Legion D'Honneur, an honor accorded to but few Americans. He was also a member of the U. S. Commission at the Electrical Congress held during the Philadelphia Electrical Exhibition of the Franklin Institute in 1884. He served also on the Jury of Awards at the World's Columbian Exposition in 1893.

During his long connection with the University of Pennsylvania, his services were valued very hightly by his associates; he was always helpful in the solution of the problems presented, and brought to bear a ripe judgment so as to decide upon the course to be taken in any case with fairness and calmness. His service to the community was none the less valuable. This was evident in his work while a member of the Board of Public Education, and his counsel in relation to such matters as water supply, illuminating gas and other municipal problems was much esteemed. Dr. Barker was one of the first to point out the fallacies and trickery of the famous Keely motor scheme, and to denounce it in the public prints. This scheme was actively exploited in the late seventies in Philadelphia. Needless is it to say that all the subsequent history of that long-lived fraud, and its final wind-up and exposure upon the death of Keely amply confirmed the entire justice of Dr. Barker's original denunciation of it.

As an author and writer he was, as in other things, most careful

and conscientious. His text-book on "Elementary Chemistry" which first appeared in 1870 went through many editions, and was esteemed as embodying the most advanced thought, presented for the first time in our language thoroughly and systematically. No less an authority than Wolcott Gibbs commended the book highly.

Barker's "Physics, Advanced Course" published in 1892 as one of the American Science Series, was likewise an embodiment of the most modern views and met with a hearty reception. The treatment was mainly from the standpoint of energy and interchanges therein, and the ether of space was frankly assumed as the fundamental thing in dealing with all forms of radiation. From his habit of mind it was to be expected that in his scientific papers we should also find the results of the latest investigations. He was particular in giving a comprehensive bibliography of the subject, where it was possible. Thus, the valuable address delivered by him before the Chemical Society at Columbia University in March, 1903, is a model paper. Its subject was "Radio-Activity and Chemistry," and its great historical value will be understood when it is stated that to it is appended a bibliography of no less than ninety titles of papers by the leading investigators.

Some of his earlier papers and addressess assisted to a considerable degree in enforcing the great principles of conservation and correlation of forces, the discussion of which was carried on actively in the period between 1860 and 1880. Before those years the ideas of permanence of energy and the importance of energy interchanges had not received universal recognition or acceptance. It is now generally recognized that the indestructibility of energy is a more necessary postulate than the indestructibility of matter.

Dr. Barker's logical mind did not limit itself to the consideration of physical forces merely. He had taken the degree of doctor of medicine and it was natural that he should be led to consider the relations between the physical and so-called vital forces. We find his views expressed in a paper entitled "The Correlation of Vital and Physical Forces," published in 1875 by Van Nostrand, and also in his address as retiring president of the American Association for the Advancement of Science, at the Boston meeting in 1882. This

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latter address was entitled "Some Modern Aspects of the Life Question." He identifies vital force or energy as that stored in the complex protoplasm under physical and chemical conditions only; a view which more and more guides the biochemists of today in their researches. The Association address is an excellent example of clear logical scientific thinking. In it Dr. Barker drew ably from his rich fund of knowledge in physics, chemistry, biology, and kindred branches. He claims for science its true position as interpreter of the things which can be known, but points out clearly the limitations of this knowledge.

The writer may be pardoned making a few quotations:

> But the properties of bodies are only the characters by which we differentiate them. Two bodies having the same properties would only be two portions of the same substance. Because life, therefore, is unlike other properties of matter, it by no means follows that it is not a property of matter. No dictum is more absolute in science than the one which predicates properties upon constitution. To say that this property exhibited by protoplasm, marvellous and even unique though it be, is not a natural result of the constitution of matter itself, but is due to an unknown entity, a *tertium quid* which inhabits and controls it, is opposed to all scientific analogy and experience. To the statement of the vitalist that there is no evidence that life is a property of matter, we may reply with emphasis that there is not the slightest proof that it is not.

Again, at the close of the address, speaking of the dependence of all activity on the earth upon solar radiation:

> It is a beautiful conception of science which regards the energy which is manifested on the earth as having its origin in the sun. Pulsating awhile in the ether, the molecules of which fill the intervening space, this motion reaches our earth and communicates its tremor to the molecules of matter. Instantly all starts into life. The winds move, the waters rise and fall, the lightnings flash and the thunders roll, all as subdivisions of this received power.

And further:

> But all this energy is only a transitory possession. As the sunlight gilds the mountain top and then glances off into space, so this energy touches upon and beautifies our earth and then speeds on its way. What other worlds it reaches and vivifies, we may never know. Beyond the veil of the seen, science may not penetrate. But religion, more hopeful, seeks there for the new heavens and the new earth wherein shall be solved the problems of a higher life.

That the taking up of the teaching of physics by Dr. Barker did not prevent a continued interest in chemical studies is shown by his serving as the chairman of the sub-section of chemistry of the American Association in 1876, when he delivered a notable address on "The Molecule and the Atom." In this he points out the importance of considering the energy interchanges in chemical reactions, a matter which up to that time had been more or less neglected. Even as late as 1891, he was honored by being made president of the American Chemical Society, and delivered an address on the "Borderland between Physics and Chemistry," in which he dealt with the necessity for distinguishing the fundamental notion of "mass" from that of "weight." He further showed the rich harvest to be expected in the application of the kinetic theory to solutions, and concluded by a remarkably clear exposition of what was then known of the nature of electric forces in their relation to chemical actions. In these later years, it has indeed been the field of physical chemistry which has yielded an abundant harvest; the advances in it have been of the greatest importance to science. Indeed, the electro-physicist of today has even split the one time ultimate chemical atom into the more fundamental electrons. We must credit Dr. Barker with a keen appreciation of the directions in which further scientific advances were to be made.

None the less clear was his prevision of the future of applied science. In this connection the writer must content himself by quoting from a brief paper read at the Saratoga Meeting of the American Association for the Advancement of Science in 1879. The title of the paper was "On the Conversion of Mechanical energy into Heat by Dynamo Electric Machines." It must be remembered that at the time the paper was read no practical incandescent electric lamp had been made, and industrial electric development had scarcely begun even with the older arc light. The quotation reads:

> The amount of heat actually obtainable from dynamo electric machines when worked upon a commercial scale, is a question which in the near future is to become of very considerable commercial importance. That electric distribution, at least in our larger cities, is ultimately to be the source of light supply, is already placed beyond a peradventure. But far more than

a simple light production is to be expected of this marvellous agent. It must not only light our houses, but it must warm them and must furnish mechanical power to them for a thousand petty operations now either done not at all, or done by manual labor. It must pump the water, raise the elevator, run the sewing machine, turn the spit, perform its part of the laundry service, and perhaps even assist in the cooking.

As before indicated, it was natural that the early work of Edison on the carbon filament lamp should greatly interest Dr. Barker. This lamp was not brought out until 1880, but we find that it was in that year tested as a light source by him, acting in collaboration with Professor Henry A. Rowland. The results were published in the *American Journal of Science,* and in the *Chemical News.* This account of early tests was followed in 1881 by papers dealing with the general subject of electric light photometry and by results of tests. Dr. Barker was chairman of the Sub-commission on Incandescent Lamps at the Paris Electrical Exposition in 1881, the other members being Wm. Crookes, E. Hagenbach, A. Kundt and E. Mascart. There is no need to make any comment on the standing of these men. Their work was in fact pioneer work done at the start of an industry which today has become one of enormous importance. As the Paris Exposition of 1881 was the first to be devoted entirely to electricity and its applications, it possessed a peculiar interest. The International Congress of Electricians held at the same time has been before referred to. Dr. Barker prepared a report on the proceedings of this congress.

As an example of painstaking and exhaustive work in another field, by a committee of which he was the head, may be mentioned the Report of the Committee of the National Academy of Sciences, on Glucose. The investigation was undertaken at the request of the Commissioner of Internal Revenue, as the information was needed as a guide to Congress in legislation concerning the manufacture and sale of glucose sugar. The other members of this committee were W. H. Brewer of Yale, C. F. Chandler of Columbia, Wolcott Gibbs of Harvard, and Ira Remsen of Johns Hopkins. The report covers more than 100 pages and must have represented a great amount of work. The subject is most thoroughly dealt with, and to the report is appended a complete bibliography.

A glance at the list of writings of Dr. Barker will show at once

the great range of subjects about which he had informed himself, and upon which he was equipped to accomplish valuable scientific work. His alertness of mind, even a few years before his death, is plainly evident in his later papers on such subjects as radio-activity and intra-atomic energy in 1903, and before that time in his discussion of liquefied air, Roentgen rays, wireless telegraphy, monatomic gases, etc.

From the fact that he survived many of his contemporaries and associates in scientific work, it was natural that it should have fallen to his lot to prepare memoirs to some of these to whom he was most closely drawn. How well the work was done, with what conscientious care as to facts, and in what personal estimation he held these friends, can only be understood by a careful reading of these memoirs. Coupled with tender remembrances, they show a sincere admiration for the accomplishments, the discoveries and researches which he so ably describes. He spared no pains to bring out clearly, and often in detail, the things for which his friend was best known, his scientific methods and results, and throughout all this his keen personal interest and affectionate regard is manifested. This largeness of view and willingness to devote much time and effort to assist in securing that place in science which his friends' work seemed to him to deserve, appears to the writer as quite characteristic, and implies a most generous spirit. Examples of the truth of this will be found in his memoirs of John William Draper, and of his son, Dr. Henry Draper, read before the National Academy of Sciences, one in April, 1886, and the other in April, 1888. The elder Draper died early in 1882, and his son Henry late in the same year.

The splendid achievements of the elder Draper in science and philosophy are well known, and are most ably dealt with in the memoir referred to, while Dr. Barker's close personal relations with Henry Draper gave him excellent opportunities for obtaining the biographical material which he has incorporated in the memoirs. Henry Draper devoted himself to optical and astronomical science, constructing improved instruments and devising new methods. Of him Dr. Barker writes from the standpoint of a warm personal friend telling of a most fruitful career too soon closed; a scientist of

the highest type stricken in the midst of his life work, with the brighter promises of his future unfulfilled.

A memoir on the eminent chemist and mineralogist, Dr. F. A. Genth, was read by him before the American Philosophical Society in 1901, and also before the National Academy of Sciences. For the latter society he also prepared an extended memoir of another noted chemist, Matthew Carey Lea; in which is given a careful, critical résumé of Lea's remarkable investigations and discoveries, chiefly in chemistry, optics and photography.

Dr. Barker was born July 14, 1835, at Charlestown, Mass., and attended school there, afterwards going to Berwick and Yarmouth academies in Maine, and to Lawrence Academy in Groton, Mass. When about sixteen he entered as apprentice the establishment of J. M. Wightman in Boston, a maker of philosophical instruments, and remained there five years. This apprentice period must have given a training very valuable to one who was afterward to so freely use scientific apparatus. After taking the degree of Bachelor of Philosophy at the Sheffield Scientific School, where he was also assistant to Professor Silliman, he entered the Harvard Medical School as a student and assistant in chemistry.

From this time his career as a science teacher and lecturer was continued with but little interruption. He received the degree of Doctor of Medicine from the Albany Medical College in 1863, having completed his medical course there while Acting Professor of Chemistry in the school. In 1864 he served as professor of natural sciences in the Western University of Pennsylvania, soon thereafter going to Yale as demonstrator in the medical department, where in 1867 he was appointed Professor of Physiological Chemistry and Toxicology, a chair which he held for six years, when he was appointed Professor of Physics in the University of Pennsylvania. Beginning in 1873 he continued this work as head of the department for twenty-seven years, becoming Professor Emeritus in 1900.

Before coming to Philadelphia he had acted as State Chemist in Connecticut, giving testimony in some noted cases of poisoning. He was also at times engaged as expert in patent cases, concerning electric lighting, telephones, batteries and chemical processes.

It was only to be expected that one so able and active as he was should become the recipient of many honors. Besides those already mentioned, including positions of honor on important commissions and the like, he was given the honorary degree of Doctor of Science by the University of Pennsylvania in 1898, and in the same year, the degree of Doctor of Laws from Allegheny College and also from McGill University. He was elected a member of the National Academy of Sciences in 1876 and later an honorary member of the Royal Institution of Great Britain. He was also a member of scientific societies in France and Germany. He attended many notable educational and scientific meetings as a delegate from societies or from the University which he so long served. He was assistant editor of the *American Journal of Science,* from 1868 to 1900, and contributed for a number of years accounts of the year's progress in physics, to the annual Smithsonian Reports.

Dr. Barker was married in 1861 to Mary M. Treadway, of New Haven, who survives him, and had five children, of whom three daughters are living. He was in his seventy-fifth year when he died in Philadelphia, last May.

Thus closed a life of great and varied service, one devoted to high ideals—a striking example of industry and achievement, a life spent in doing good. Thus ended the career of a lifelong student of science of an exceptional range of accomplishment, an excellent teacher, and a man of noblest aspirations. To those who knew him well there remains the vivid remembrance of his sterling worth and fine personal qualities.

A list of his principal publications and papers is appended.

ELIHU THOMSON.

SWAMPSCOTT, MASS.,
April, 1911.

BIBLIOGRAPHY.

1863. The Forces of Nature. An address delivered before the Chemical Society of Union College, July 22, 1863. Printed separately. Pamphlet 45 pp., Albany, N. Y., 1863.

1864. Account of the Casting of a Gigantic Rodman Gun at Pittsburg. *Am. J. Sci.*, **37**, (2), 296–301.

1864. Report of a Trial for Poisoning by Strychnia. *Am. J. Medical Sciences*, **43**, 399–480.

1866. Principles of Modern Chemistry. Part I. Chemical Philosophy. (With Benjamin Silliman.) 8vo, pp. 100, Theodore Bliss & Co., Philadelphia.

1867. On Silvering upon Glass. *Am. J. Sci.*, **43**, (2), 252.

1867. Formic versus Carbonous Acid. *Am. J. Sci.*, **44**, (2), 263–264.

1867. On Normal and Derived Acids. *Am. J. Sci.*, **44**, (2), 384–398.

1868. Notices of Papers in Physiological Chemistry. On Hoematoidin. On the Coloring Matter of the Yolk of the Egg. On the Chemical Constituents of the Supra-renal Capsules. On the Rational Formula of Urea. *Am. J. Sci.*, **46**, (2), 233–239.

1868–9. Notices of Papers in Physiological Chemistry. On Formation of Sugar in the Liver. *Am. J. Sci.*, **46**, (2), 379–390; **47**, 20–32, 258–270, 373–398; **48**, 49–64.

1870. A Textbook of Elementary Chemistry. Theoretical and Inorganic. Charles C. Chatfield & Co., New Haven, Conn.

1870. Abstract of the Second Series of Prof. Meissner's Researches on Electrized Oxygen. *Am. J. Sci.*, **50**, (2), 213–223.

1870. The Correlation of Vital and Physical Forces. A lecture delivered before the American Institute, New York, December 31, 1869. No. 2 University Series, pp. 36, C. C. Chatfield & Co. New Haven. Canadian Naturalist, **5**, 416–437. Les Mondes, **23**, 113–117, 151–157, 201–208. Half hours with Modern Scientists (Huxley, Barker, Stirling, Cope and Tyndall). Vol. 2, pp. 37–72. C. C. Chatfield, New Haven.

1871. On the Rational Formulas of the Oxides of Chlorine and of Oxides Analogously constituted. *Am. Chemist*, **2**, 1–4.

1871. On Molecular Classification. *Am. Chemist*, **1**, 359–360.

1871. A Textbook of Elementary Chemistry. Theoretical and Inorganic. Fifth edition. Charles C. Chatfield & Co., New Haven, Conn. (Translated into French, Japanese and Arabic.) 12mo, 342 pp.

1872. Acoustic Illustration of the Method by which Stellar Motions are Determined with the Spectroscope. (Account of address by Alfred M. Mayer.) *Am. Chem.*, **2**, 412–413.

1872. The Chemical Testimony in the Sherman Poisoning Case. *Am. Chem.*, **2**, 441–445.

1872. Note on the Spectrum of the Aurora. *Am. J. Sci.*, **2**, (3), 465–466. *Am. Chem.*, **2**, 248–249; *Nature*, **5**, 172–173.

1873. On the Spectrum of the Aurora of October 14, 1872. *Am. J. Sci.*, **5**, (3), 81–84.

1875. A New Vertical Lantern Galvanometer. *Jl. Franklin Inst.*, **69**, 431–437; *Am. J. Sci.*, **10**, (3), 207–212; *Proc. Am. Phil. Soc.*, **14**, 440–445; *Phil. Mag.*, **50**, 434–440. Carl Repertorium **12**, 46–52.

1876. The Molecule and the Atom. (An address to the Chemical Subsection of the American Association for the Advancement of Science at its Buffalo meeting.) Proc. Am. Assn. Ad. Sci., **25**, 85–107.

1876. Chemistry. Johnson's Universal Cyclopedia, Vol. I, pp. 901–906.

1877. Improved Method of Obtaining Metallic Spectra. Read before National Academy of Sciences, April, 1877. Rept. Nat. Acad. Sci. for 1883, p. 47.

1878. Magneto-electricity—III. Johnson's Universal Cyclopedia, Vol. IV, appendix, pp. 1616–1623.

1878. On a new Method of Measuring the Pitch of a Tuning-Fork. Proc. Am. Assn. Ad. Sci., **27**, 118–121.

1878. On the Microphone of Hughes. *Am. J. Sci.*, **16**, (3), 60–63.

1878. On the Results of the Spectroscopic Observation of the Solar Eclipse of July 29, 1878. (A report to Dr. Henry Draper, The Director.) Proc. Am. Assn. Ad. Sci., **27**, 113–118; *Am. J. Sci.*, **17**, (3), 121–125.

1878. On the total Solar Eclipse of July 29, 1878. *Proc. Am. Phil. Soc.*, **18**, 103–114.

1879. On Arago's Experiment showing the Magnetism of a Conductor. Read before National Academy of Sciences, October, 1879. Rept. Nat. Acad. Sci. for 1883, p. 51.

1879. Instructions for Disinfection. (George F. Barker, C. F. Chandler, Henry Draper, Edward G. Janeway, Ira Remsen, S. O. Vander Poel.) The National Board of Health, leaflet, 1879.

1879. On the Conversion of Mechanical Energy into Heat by Dynamo-Electric Machines. Proc. Am. Assn. Ad. Sci., **28**, 160–169.

1879. On a Curious Case of Crystallization of Canada Balsam. Proc. Am. Assn. Ad. Sci., **28**, 169–172.

1879. Note on J. C. Draper's paper "On the Presence of Dark Lines in the Solar Spectrum which correspond closely to the lines of the Spectrum of Oxygen." (A critical review.) *Am. J. Sci.*, **17**, (3), 162–166; *Spettrosc. Ital. Mem.*, **8**, 16–20.

1880. Report on the Manly Telegraph Cable. Pamphlet 8vo, 15 pp., Philadelphia.

1880. On Condensers for Currents of High Potential. Read before National Academy of Sciences, November, 1880. Rept. Nat. Acad. Sci. for 1883, p. 53.

1880. On the Efficiency of Edison's Electric Light (with H. W. Rowland). *Am. J. Sci.*, **19**, (3), 337–339; *Chem. News*, **41**, 200–201.

1880. Report on the Contamination of the Water of the Schuylkill River. Pamphlet, 8vo, 15 pp., Philadelphia, Pa., 1880.

1881. Some Modern Aspects of the Life-Question. Address as retiring President at the Boston meeting of the American Association for the Advancement of Science in 1880. Proc. Am. Assn. Ad. Sci., **29**, 1–30; *Revue scientif.*, **4**, 225–235, 1882.

1881. On the International Congress of Electricians at Paris. *Am. J. Sci.*, **22**, (3), 395–396.

1881. On Electric Light Photometry. Read before National Academy of Sciences. April 1881. Rept. Nat. Acad. Sci. for 1883, p. 53.

1881. On the Condenser Method of Measuring High Tension Currents. Read before National Academy of Sciences, April, 1881. Rept. Nat. Acad. Sci. for 1883, p. 53.

1881. On the Carbon Lamp-fiber in the Thermo balance. Read before National Academy of Sciences, April, 1881. Rept. Nat. Acad. Sci. for 1883, p. 53.

1881. On Incandescent Lights. Read before National Academy of Sciences, April, 1881. Rept. Nat. Acad. Sci. for 1883, p. 53.

1881. Physics (An Account of Recent Progress). Ann. Rept. Smith. Inst. for 1879–80, 235–288.

1881. Chemistry (An Account of Recent Progress). Ann. Rept. Smith. Inst. for 1879–80, pp. 289–297.

1881. On Mascart's Electrometer and Its Use as a Meteorological Instrument. Read before the National Academy of Sciences, November, 1881. Rept. Nat. Acad. Sci. for 1883, p. 54.

1881. An Account of Recent Progress in Physics and Chemistry (For the Years 1879 and 1880). From the Smithsonian Report for 1880. Pamphlet, 8vo, pp. 2 + 63.

1882. On the Results of the Incandescent Lamp Tests at the Paris Exhibition. Read before National Academy of Sciences, April, 1882. Rept. Nat. Acad. Sci for 1883, p. 54.

1882. On an Improved Form of Standard Daniell Cell. Read before National Academy of Sciences, November, 1882. Rept. Nat. Acad. Sci. for 1883, p. 55.

1882. Report of the Sub-Commission on Incandescent Lamps at the International Exhibition of Electricity, Paris, 1881. (George F. Barker, William Crookes, Ed. Hagenbach, A. Kundt, E. Mascart.) Pamphlet, 8vo, 28 pp., New York.

1882. On Secondary Batteries. Proc. Am. Assn. Ad. Sci., **31**, 207–217; *Chem. News*, **47**, 196–199, 1883.

1882. Henry Draper. A minute prepared as Secretary of the American Philosophical Society. *Proc. Am. Phil. Soc.*, **20**, 656–662, December, 1882.

1883. Physics (An Account of Recent Progress). Ann. Rept. Smith. Inst. for 1880–81, pp. 333–379.

1883. Chemistry (An Account of Recent Progress). Ann. Rept. Smith. Inst. for 1880–81, pp. 381–390.

1883. An Account of Progress in Physics and Chemistry in the year 1881. From the Smithsonian Report for 1881. Pamphlet, 8vo, pp. 2 + 58.

1883. The Future of American Science. (Anon.) *Science*, **1**, 1–3.

1883. Henry Draper. A Biographical Notice. *Am. J. Sci.*, **25**, (3), 89–95.

1883. On the Variability of the Law of Definite Proportions. *Am. J. Sci.*, **26**, (3), 63–67.

1883. On the Measurement of Electromotive Force. *Proc. Am. Phil. Soc.*, **21**, 649–655.

1883. Report of Committee on Methylated Spirits. (Ira Remsen, C. F. Chandler, George F. Barker.) Rept. Nat. Acad. Sci. for 1883, pp. 57–63.

1883. Report of Committee on Glucose. (George F. Barker, William H. Brewer, Wolcott Gibbs, Charles F. Chandler, Ira Remsen.) Rept. Nat. Acad. Sci. for 1883, pp. 65–143.

1883. Efficiency of Storage Batteries. Read before National Academy of Sciences, April, 1883. Rept. Nat. Acad. Sci. for 1883, p. 56.

1884. On a Lantern Voltameter. Read before the National Academy of Sciences, April, 1884. Rept. Nat. Acad. Sci. for 1884, p. 6.

1884. On the Fritts Selenium Cell. Read before the National Academy of Sciences, April, 1884. Rept. Nat. Acad. Sci. for 1884, p. 6.

1884. Physics (An Account of Progress in the year 1882). Ann. Rept. Smith. Inst. for 1881–82, pp. 459–508. Separate, 1883, 8vo, pp. 2 + 50.

1884. Report on Glucose (Committee of Nat. Acad. Sci. Geo. F. Barker, Chairman). Govt. Print. Off., Pamphlet, 8vo, 108 pp., Wash.

1884. The British Association at Montreal. *Am. J. Sci.*, **28**, (3), 300–303.

1884. The American Association at Philadelphia. *Am. J. Sci.*, **28**, (3), 303–307.

1884. The National Conference of Electricians at Philadelphia. *Am. J. Sci.*, **28**, (3), 386–390.

1884. Shall the Ammonium Theory be Applied to Alkaloidal Salts? (Symposium.) *Weekly Drug News and Prices Current*, **9**, 705–706.

1885. Physics (An Account of Progress in the Year 1883). Ann. Rept. Smith. Inst. for 1882–83, pp. 571–628. Separate, 1884, 8vo, pp. 2 + 52.

1885. On the Use of Carbon Bisulphide in Prisms. Being an account of Experiments made by the late Dr. Henry Draper of New York. *Am. J. Sci.*, **29**, (3), 269–277.

1885. Report of Committee on Philosophical and Scientific Apparatus. (George J. Brush, Wolcott Gibbs, Samuel H. Scudder, Simon Newcomb, George F. Barker.) Rept. of Nat. Acad. Sci. for 1884, pp. 65–67.

1885. Physics (An Account of Progress in the year 1884). Ann. Rept. Smith. Inst. for 1883–84, pp. 433–489. Separate, 1885, 8vo, pp. 2 + 57.

1886. Memoir of John William Draper, 1811–1882. Read before Nat. Acad. of Sci., April, 1886. Biographical Memoirs. Nat. Acad. Sci., **2**, 349–388.

1886. Protection of (Philadelphia) Public Buildings (City Hall) from Lightning. Rept. Commissioners for the Erection of "The Public Buildings," pp. 25–28, Philadelphia, 1886.

1886. Physics (An Account of Progress in the Year 1885). Ann. Rept. Smith. Inst. 1884–85, pp. 577–636. Separate, 1886, 8vo, pp. 2 + 60.

1886. Telephone. Johnson's (revised) Universal Cyclopedia, **7**, 736–737.

1887. On the Henry Draper Memorial Photographs of Stellar Spectra. *Proc. Am. Phil. Soc.*, **24**, 166–171.

1889. Physics in 1886 (An Account of Progress in the Year 1886). Ann. Rept. Smith. Inst. for 1886–87, pp. 327–386. Separate, 1889, 8vo, pp. 60.

1891. On Zinc Storage Batteries. Read before the National Academy of Sciences, November, 1889. Report Nat. Acad. Sci. for 1889, p. 12.

1891. Report of Committee appointed by the National Academy of Sciences on the Henry Draper Medal. (George F. Barker, Wolcott Gibbs, Simon Newcomb, Arthur W. Wright, C. A. Young.) Rept. Nat. Acad. Sci. for 1889, pp. 53–63.

1891. A Textbook of Elementary Chemistry, Theoretical and Inorganic. Revised and Enlarged. 8vo, 348 pp. John P. Morton & Co., Louisville, Ky.

1891. The Borderland between Physics and Chemistry. Address as President of the American Chemical Society. *J. Am. Chem. Soc.*, **13**, 13–29.

1891. The Physiology of Manual Training. An address at the Opening of the Williamson Free School of Mechanical Trades. The Williamson Free School of Mechanical Trades. Pp. 61–69, Philadelphia, 1891.

1891. The Modern View of Energy. Syllabus of a Course of Six Lectures. University Extension Lectures of Am. Soc. for Ex. of Univ. Teaching. Series A, No. 30, pp. 16, 1891.

1892. A Textbook on Physics. Advanced Course. Lg. 8vo, 902 pp. (Ten editions.) American Science Series, Henry Holt & Co., N. Y.

1893. On the Storage of Electrical Energy. *N. Y. Independent*, **45**, 280–281.

1894. Electrical Progress since 1743. A Paper read before the American Philosophical Society on the Occasion of the Celebration of the 150th Anniversary of its Foundation, May 27, 1893. *Proc. Am. Phil. Soc.*, **32**, 104–154.

1895. Memoir of Henry Draper. Read before Nat. Acad. of Sci. April, 1888. Biographical Memoirs Nat. Acad. Sci., **3**, 81–139.

1897. Sketch of Moses Gerrish Farmer. An address before the American Institute of Electrical Engineers at Greenacre, Me., July 20th, 1897. *Trans. Am. Inst. Electrical Engineers*, **14**, 414–417.

1897. The American Philosophical Society. A paper read at the Greenacre Conference, July, 1897. *Electrical Eng.*, **24**, 90.

1898. Liquefied Air. A lecture delivered before the Scientific Association of Johns Hopkins University, March 24, 1898. *Balt. Am.*, March 25.

1898. Address on Alexander Dallas Bache, made on Presentation of Portrait to the Bache Public School of Philadelphia, April 13, 1898. Presentation of the Portrait of Professor Alexander Dallas Bache, pamphlet, pp. 12–17, Philadelphia.

1898. Röntgen Rays. Memoirs by Röntgen, Stokes and J. J. Thomson. Translated and edited by George F. Barker. Sm. 8vo, 82 pp. Scientific Memoir Series. Harper and Brothers, New York.

1898. Liquid Air. A Lecture delivered before the Friends Institute Lyceum, Philadelphia, Pa. Sci. Am. Sup., Sept. 24, pp. 19021–19022, 19036–19037. *The Chautauquan*, **27**, 526–529.

1899. Wireless Telegraphy through Scientific Eyes. *Lippincott's Mag.*, **64**, 301–311.

1899. The Hydrogen Vacua of Dewar. Read before the National Academy of Sciences. Rept. Nat. Acad. Sci. for 1899, p. 13.

1899. Air as a Liquid. *N. Y. Independent,* May 25, pp. 1419–1422.

1901. Memoir of Frederick Augustus Genth. Read before the American Philosophical Society. December 6, 1901. *Proc. Am. Phil. Soc.,* **40** (Obituary Notices), X–XXII.

1901. The Monatomic Gases. Read before the National Academy, November, 1901. Rept. Nat. Acad. Sci. for 1901, p. 16.

1901. On the Newer Forms of Incandescent Electric Lamps. Read before the National Academy, November, 1901. Rept. Nat. Acad. Sci. for 1901, p. 16.

1902. Biographical Memoir of Frederick Augustus Genth, 1820–1893. Read before the National Academy of Sciences, November 12, 1901. Biographical Memoirs Nat. Acad. Sci., Vol. 5, 202–231.

1903. Radioactivity and Chemistry. An address delivered before the Chemical Society of Columbia University, March 19, 1903. *School of Mines Quarterly,* **24,** 267–302.

1903. On the Radioactivity of Thorium Minerals. Read before the National Academy of Sciences, April, 1903. *Am. J. Sci.,* **16,** (4), 161–168.

1903. Intratomic Energy; the Unmeasurable Force of Inanimate Nature. *N. Y. Sun,* p. 6, July 12.

1904. On Radioactivity and Autoluminescence. Read before the National Academy of Sciences, April, 1904. Rept. Nat. Acad. Sci. for 1904, p. 13.

1905. Biographical Memoir of Matthew Carey Lea, 1823–1897. Read before the National Academy of Sciences, April, 1903. Biographical Memoirs Nat. Acad. Sci., Vol. 5, 154–208.